ANNA UNIVERSITY::CHENNAI 600025
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
M. TECH.NANOSCIENCEANDTECHNOLOGY
CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To prepare students to outshine in academics and research in different motifs of Nanoscience and Nanotechnology through post graduate education.
2. To provide students with a solid foundation in Synthesis and Characterization of novel nanomaterials with multiple applications and further train them with good theoretical and practical knowledge to comprehend, analyze, design, and create novel products and solutions for the real life problems.
3. To coach students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate nanotechnology to address environmental issues.
4. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

2. PROGRAMME OUTCOMES (POs):

On successful completion of the M.Tech. Nanoscience and technology programme:

PO	Program Outcome
1.	Graduates will demonstrate good knowledge of Physics, Chemistry, Synthesis & Characterization of Nanomaterials to solve engineering and research problems
2.	They will be able to design and conduct experiments, analyze and interpret data
3.	The graduates will be capable of demonstrating an ability to design an experiment, component or process as per needs and specifications.
4.	An ability to independently carry out research/investigation and development work to solve practical problems
5.	An ability to write and present a substantial technical report/document
6.	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

Programme Educational Objectives	Program Outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	3	3	3	3	3
2	3	3	3	3	2	3
3	3	3	3	3	2	3
4	-	3	3	-	-	3

4. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

YEAR	SEMESTER	SUBJECTS	PROGRAMME OUTCOME					
			PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEMESTER I	Mathematical modeling and simulation	3	3	-	3	-	-
		Quantum Mechanics	3	3	-	3	-	-
		Synthesis and Applications of Nanomaterials	3	3	-	3	-	-
		Biological Nanostructures	3	-	-	3	-	2
		Research Methodology and IPR	3	3	-	-	3	2
		Audit Course – I	-	-	-	-	-	-
		Lab I Computation & Simulation	-	-	3	-	3	-
		Lab II Nanomaterial Synthesis	-	-	3	-	3	-
	SEMESTER II	Imaging techniques for Nanotechnology	3	3	-	3	-	-
		Physicochemical methods for characterization of Nanomaterials	3	3	-	3	-	-
		Physics and Chemistry of Materials	3	3	-	-	-	3
		Audit Course –II	-	-	-	-	-	-
		Lab III Materials Structural characterization Lab	-	3	-	3	3	-
		Lab IV Physicochemical characterization lab	-	3	-	3	3	-
YEAR 2	SEMESTER III	Open Elective	-	-	-	-	-	-
		Project Work I	3	3	3	1	2	3
	SEMESTER IV	Project Work II	3	3	3	2	2	3

. MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

ELECTIVES		SUBJECTS	PROGRAMME OUTCOME					
			PO1	PO2	PO3	PO4	PO5	PO6
PROFESSIONAL ELECTIVE COURSES (PECs)	PEC I	Lithography and Nanofabrication	3	3	2	3	-	-
		Nanocomposite Materials	3	3	-	3	-	-
		Nanoelectronics and Sensors	3	3	2	3	-	-
	PEC II	Nanotechnology in Agriculture and Food Industry	3	3	-	3	-	-
		Nanomaterials for Energy and Environment	3	3	-	3	-	-
		Nano Biophotonics	3	3	-	3	-	-
	PEC III	Advanced Drug Delivery System	3	3	2	3	-	-
		Processing and Properties of Nanostructured Materials	3	3	-	3	-	3
		MEMS and NEMS	3	3	-	3	-	-
	PEC IV	Semiconductor Nanostructures	3	3	-	3	-	-
		Nano-toxicology	3	3	-	3	-	-
		Nanotechnology in Health Care	3	3	-	3	-	-
	PEC V	Nano Biosensors	3	3	-	3	-	-
		Nanotechnology in Tissue Engineering	3	3	-	3	-	-
		Entrepreneurship	-	-	-	-	-	-

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I TO IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4157	Mathematical Modeling and Simulation	FC	4	0	0	4	4
2.	NT4101	Quantum Mechanics	PCC	3	0	0	3	3
3.	NT4102	Physics and Chemistry of Materials	PCC	3	0	0	3	3
4.	NT4103	Biological Nanostructures	PCC	3	1	0	4	4
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	NT4111	Computation and Simulation Laboratory	PCC	0	0	4	4	2
9.	NT4112	Nanomaterial Synthesis Laboratory	PCC	0	0	4	4	2
			TOTAL	**20**	**1**	**8**	**29**	**23**

***Audit Course is optional**

SEMESTER II

S. NO.	COURSE CODE.	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	NT4201	Imaging techniques for Nanotechnology	PCC	3	0	0	3	3
2.	NT4202	Physiochemical Characterization of Nanomaterials	PCC	3	0	0	3	3
3.	NT4203	Synthesis of Nanomaterials	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Professional Elective IV	PEC	3	0	0	3	3
7.		Audit Course –II*	AC	2	0	0	2	0
PRACTICALS								
8.	NT4211	Materials Structural Characterization Laboratory	PCC	0	0	4	4	2
9.	NT4212	Physicochemical characterization Laboratory	PCC	0	0	4	4	2
10.	NT4312	Internship (2 weeks)	EEC	0	0	0	0	0
			TOTAL	**20**	**0**	**8**	**28**	**22**

***Audit Course is Optional**

SEMESTER III

S. NO.	COURSE CODE.	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective V	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
3.	NT4311	Project Work I	EEC	0	0	12	12	6
4.	NT4312	Internship	EEC	0	0	0	0	1
			TOTAL	**6**	**0**	**12**	**18**	**13**

SEMESTER IV

S. NO.	COURSE CODE.	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	NT4411	Project Work II	EEC	0	0	24	24	12
TOTAL				**0**	**0**	**24**	**24**	**12**

TOTAL NO, OF CREDITS: 70

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4157	Mathematical Modeling and Simulation	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	NT4101	Quantum Mechanics	3	0	0	3	1
2.	NT4102	Physics and Chemistry of Materials	3	0	0	3	1
3.	NT4103	Biological Nanostructures	3	1	0	4	1
4.	NT4111	Computation and Simulation Laboratory	0	0	4	2	1
5.	NT4112	Nanomaterial Synthesis Laboratory	0	0	4	2	1
6.	NT4201	Imaging techniques for Nanotechnology	3	0	0	3	2
7.	NT4202	Physiochemical Characterization of Nanomaterials	3	0	0	3	2
8.	NT4203	Synthesis of Nanomaterials	3	0	0	3	2
9.	NT4211	Materials Structural Characterization Laboratory	0	0	4	2	2
10.	NT4212	Physicochemical characterization Laboratory	0	0	4	2	2
				TOTAL CREDITS		**27**	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
TOTAL CREDITS						**2**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	NT4311	Project Work I	0	0	12	6	
2.	NT4312	Internship	0	0	0	1	
3.	NT4411	Project Work II	0	0	24	12	
TOTAL CREDITS						**19**	

LIST OF PROFESSIONAL ELECTIVE COURSES

SEMESTER I, ELECTIVE I

S. NO.	COURSE CODE.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4001	Lithography and Nanofabrication	PEC	3	0	0	3	3
2.	NT4002	Nanocomposite Materials	PEC	3	0	0	3	3
3.	NT4003	Nanoelectronics and Sensors	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4004	Nanotechnology in Agriculture and Food Industry	PEC	3	0	0	3	3
2.	NT4005	Nanomaterials for Energy and Environment	PEC	3	0	0	3	3
3.	NT4006	Nano Biophotonics	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4007	Advanced Drug Delivery System	PEC	3	0	0	3	3
2.	NT4008	Processing and Properties of Nanostructured Materials	PEC	3	0	0	3	3
3.	NT4009	MEMS and NEMS	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4010	Semiconductor Nanostructures	PEC	3	0	0	3	3
2.	NT4011	Nano-toxicology	PEC	3	0	0	3	3
3.	NT4012	Nanotechnology in Health Care	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	NT4013	Nano Biosensors	PEC	3	0	0	3	3
2.	NT4014	Nanotechnology in Tissue Engineering	PEC	3	0	0	3	3
3.	NT4015	Entrepreneurship	PEC	3	0	0	3	3

AUDIT COURSES - I (AC)

REGISTRATION FOR ANY OF THESE COURSES IS OPTIONAL TO STUDENTS

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ்இலக்கியம்	2	0	0	0

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	OCE431	Integrated Water Resources Management	3	0	0	3
2.	OCE432	Water, Sanitation and Health	3	0	0	3
3.	OCE433	Principles of Sustainable Development	3	0	0	3
4.	OCE434	Environmental Impact Assessment	3	0	0	3
5.	OIC431	Blockchain Technologies	3	0	0	3
6.	OIC432	Deep Learning	3	0	0	3
7.	OME431	Vibration and Noise Control Strategies	3	0	0	3
8.	OME432	Energy Conservation and Management in Domestic Sectors	3	0	0	3
9.	OME433	Additive Manufacturing	3	0	0	3
10.	OME434	Electric Vehicle Technology	3	0	0	3
11.	OME435	New Product Development	3	0	0	3
12.	OBA431	Sustainable Management	3	0	0	3
13.	OBA432	Micro and Small Business Management	3	0	0	3
14.	OBA433	Intellectual Property Rights	3	0	0	3
15.	OBA434	Ethical Management	3	0	0	3
16.	ET4251	IoT for Smart Systems	3	0	0	3
17.	ET4072	Machine Learning and Deep Learning	3	0	0	3
18.	PX4012	Renewable Energy Technology	3	0	0	3
19.	PS4093	Smart Grid	3	0	0	3
20.	CP4391	Security Practices	3	0	0	3
21.	MP4251	Cloud Computing Technologies	3	0	0	3
22.	IF4072	Design Thinking	3	0	0	3
23.	MU4153	Principles of Multimedia	3	0	0	3
24.	DS4015	Big Data Analytics	3	0	0	3
25.	NC4201	Internet of Things and Cloud	3	0	0	3
26.	MX4073	Medical Robotics	3	0	0	3
27.	VE4202	Embedded Automation	3	0	0	3

SUMMARY

Sl. No.	Name of the Programme: M.TECH. NANO SCIENCE AND TECHNOLOGY					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	14	13	00	00	27
3.	PEC	03	09	03	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	00	07	12	19
7.	Non Credit/Audit Course	✓	✓	00	00	
8.	**TOTAL CREDIT**	**23**	**22**	**13**	**12**	**70**

MA4157 MATHEMATICAL MODELING AND SIMULATION L T P C
4 0 0 4

COURSE OBJECTIVES:

This course will help the students to

- Acquire the knowledge of solving system of linear equations using an appropriate numerical methods.
- Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials.
- Acquire the knowledge of numerical solution of ordinary differential equation by single and multi step0 methods.
- Obtain the solution of boundary value problems in partial differential equations using finite differences.
- Study simulation and monte-carlo methods and their applications.

UNIT I MATRICES AND LINEAR SYSTEMS OF EQUATIONS 12

Solution of Linear Systems : Cramer's Rule - Gaussian elimination and Gauss Jordon methods - Cholesky decomposition method – Gauss Seidel iteration method - Eigenvalue problems : Power method with deflation for both symmetric and non symmetric matrices and Jacobi method for symmetric matrices.

UNIT II INTERPOLATION, DIFFERENTIATION AND INTEGRATION 12

Lagrange's interpolation - Newton's divided differences - Hermite's interpolation – Newton's forward and backward differences – Numerical differentiation – Numerical integration: Trapezoidal and Simpson's $\frac{1}{3}$ rules - Gaussian quadrature : 2 and 3 point rules.

UNIT III DIFFERENTIAL EQUATIONS 12

Initial value problems for first and second order ODEs : Single step methods - Taylor's series method – Euler's and modified Euler's methods - Runge - Kutta method of fourth order - Multi step methods : Milne's and Adam Bashforth methods - Boundary value problems : Finite difference approximations to derivatives - Finite difference method of solving second order ODEs .

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of second order PDE's - Finite difference approximations to partial derivatives - Elliptic equations : Solution of Laplace and Poisson equations - One dimensional parabolic equation - Bender Schmidt method - Hyperbolic equation : One dimensional wave equation.

UNIT V SIMULATION ANDMONTE CARLO METHODS 12

Random numbers : Random number algorithms and generators – Estimation of areas and volumes by Monte Carlo techniques - Numerical integration - Computing volumes – Simulation : Loaded Die Problem - Birthday problem - Buffon's needle problem - Two dice problem and Neutron shielding problem.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

- Solve an algebraic or transcendental equation and linear system of equations using an appropriate numerical method.
- Approximation of functions using polynomial interpolation, numerical differentiation and integration using interpolating polynomials.
- Numerical solution of differential equations by single and multistep methods.
- Solution of boundary value problems and initial boundary value problems in partial differential equations using finite differences.
- Simulation and Monte-Carlo methods and their applications.

REFERENCES:

1. Burden, R.L. and Faires, J.D. "Numerical Analysis", 9th Edition, Cengage Learning, Delhi, 2016.
2. Cheney, W and Kincaid D., "Numerical Mathematics and Computing", 7th Edition, CengageLearning , Delhi, 2014.
3. Jain, M.K., Iyengar, S.R.K. and Jain R.K. "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Pvt. Ltd., Delhi, 2014.
4. Landau, D.P. and Binder, K., "A Guide to Monte - Carlo Simulations in Statistical Physics", 3rd Edition, Cambridge University Press, Cambridge, 2009.
5. Maki, D P and Thompson, M., "Mathematical Modelling with Computer Simulation", Cengage Learning, Delhi , 2011.
6. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning Pvt. Ltd., Delhi, 2012.
7. Taha, H.A. "Operations Research", 10th Edition, Pearson Education India, Delhi, 2018.

	PO01	PO02	PO03	PO04	PO05	PO06
CO1	1	1	1	-	-	-
CO2	2	-	2	-	-	-
CO3	3	1	3	-	-	-
CO4	3	1	3	-	-	-
CO5	2	1	2	-	-	-
Avg.	2.2	0.8	2.2	-	-	-

NT4101 QUANTUM MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn basics of Quantum mechanics.
- To know more about approximation methods, time dependent and independent Schrodinger equation.
- To know the concept of Quantum computation

UNITI BASICS OF QUANTUM MECHANICS 9

Wave-particle duality, group velocity,Phasevelocity,De-Broglie wavelength, Uncertainty principle and Schrödinger equation.

UNITII TIME DEPENDENTSCHRÖDINGER EQUATION 9

Solutions of the one-dimensional Schrödinger equation for freeparticle, particle in a box, particle in a infinitely deep wellpotential, linear harmonic oscillator. Reflection and transmission by a potential step.

UNITIII TIME INDEPENDENTSCHRÖDINGER EQUATION 9

Particle in a three dimensional box,linear harmonic oscillator and its solution, density of states, free electrontheoryofmetals.Theangularmomentumproblem.Thespinhalfproblemandproperties of Pauli spinmatrices.

UNITIV APPROXIMATE METHODS 9

Time independent and time dependent perturbation theory fornon-degenerate and degenerate energy levels, the variational method, WK Bapproximation, adiabatic approximation, sudden approximation

UNITV QUANTUMCOMPUTATION 9

Concept of quantum computation, Quantum Q-bits, Introduction to nuclearspin, quantum confinement, quantum devices, single electron devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Gaining knowledge about basics of wave-particle duality and Quantum mechanics
CO2: Acquire knowledge about wave function and free electron theory
CO3: Acquire knowledge about Quantum computation and approximation methods

REFERENCES:

1. Beiser- Modern Physics–2009,6thedition.
2. Bransden and Joachen- Quantum Mechanics-2000.2ndedition
3. Eisberg, Robert; Resnick, Robert-Quantum Physics of Atoms, Molecules, Solids, Nuclei, And Particles,1985, 2nd Edition,
4. AjoyGhatak-Quantum Physics–Theory and application, Springer 2004.
5. R.Shankar, Principles of Quantum Mechanics–2000,2nd edition.
6. Cohen-Tannoudji, Quantum Mechanics-Vol 1&2,1997.

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Gaining knowledge about basics of wave- particle duality and Quantum mechanics	3	3		3		
CO2	Acquire knowledge about wave function and free electron theory	3	3		3		
CO3	Acquire knowledge about Quantum computation and approximation methods	3	3		3		
	Overall CO	3	3		3		

NT4102 PHYSICS AND CHEMISTRY OF MATERIALS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To gain knowledge on Physical and chemical aspects of Nanomaterials.
- To know about diffusion and surface defects, nanostructures and Nanosystems.

UNITI PHYSICS ASPECTS **9**

Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials – surface area and aspect ratio- band gapenergy- quantum confinement size effect.

UNITII CHEMISTRY ASPECTS **9**

Photochemistry and Electrochemistry of nanomaterials–Ionic properties of nanomaterials-Nanocatalysis-Nanoscale heat transfer-Electron transport in transition metals and semi conducting nanostructures.

UNITIII DIFFUSION AND SURFACE DEFECTS **9**

Fick'sLaw-mechanisms of diffusion-influence ofpressure and temperature-Kirkendall effect- surface defects in nanomaterials- effect of microstructure on surface defects-interfacial energy.

UNITIV NANOSTRUCTURES **9**

Classifications of nanomaterials-Zero dimensional, one-dimensional and two dimensional nanostructures-Kinetics in nanostructured materials-multi layer thin films and super lattice-clusters of metals, semiconductors and nanocomposites.

UNITV NANOSYSTEMS **9**

Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswal dripening process- influence of reducing agents solid state phase segregation-Mechanisms of phase transformation-grain growth and sintering –precipitation in solid solution-Hume-Rothery rule.

TOTAL: 45PERIODS

COURSE OUTCOMES:

CO1: Gaining knowledge on physical and chemical aspects of Nanomaterials
CO2: Students will understand about the diffusion and surface defects in nanomaterials
CO3: Students will learn about various kinds of nanostructures and Nanosystems

REFERENCES:

1. K.W.Kolasinski,“SurfaceScience:FoundationsofCatalysisandNanoscience”,WileyLondon, 2002.
2. G. Cao, Nanostructures & Nanomaterials: Synthesis,Properties & Applications, Imperial College Press,London,2004.
3. Joel I.Gersten, “The Physics and Chemistry of Materials”,Wiley, London 2001.
4. A.S. Edelstein and R.C. Cammarata, “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Pub., London,1998.
5. S.Yangand P.Shen: “Physics and Chemistry of Nanostructured Materials”, Taylor & Francis, NewYork,2000.
6. G.A. OzinandA.C. Arsenault, “Nanochemistry: A chemical approachto Nanomaterials”, Royal Society of Chemistry,London2005.
7. AtkinsPeter, PaulaJulio Physical Chemistry,

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Gaining knowledge on physical and chemical aspects of Nanomaterials	3	3				3

CO2	Students will understand about the diffusion and surface defects in nanomaterials	3	3				3
CO3	Students will learn about various kinds of nanostructures and Nanosystems	3	3				3
	Overall CO	3	3				

NT4103 BIOLOGICAL NANOSTRUCTURES L T P C
3 1 0 4

COURSE OBJECTIVES:

- Impart knowledge on the nanostructures and nanoscale phenomenon in cells.
- To understand the different three-dimensional DNA nanostructures and their uses.
- Familiarize the concepts involved in protein corona with reference to protein nanoparticles and enzyme nanotechnology.
- Acquaint with the glyco-metal, glyco-carbon nanoparticles and their fate.
- Explain the synthesis and applications of lipid-based nanostructures

UNIT I CELLULAR NANOSTRUCTURES 12

Cellular elements in developing functional nanostructures and nanomaterials–Nanopatterning – Cytoskeletal nanomechanics – Bacterial and viral nanostructured materials – Plant-derived nanostructures: types, evolution and applications – Phytochemicals in the genesis of nanoparticles.

UNIT II DNA NANOARCHITECTURE 12

Genome structure and organization in prokaryotes and eukaryotes - Structure and function of nucleic acids – The Central Dogma of life – DNA tile assembly, brick assembly, 3D DNA nanostructures – Organic and inorganic DNA nanostructures – DNA aptamer and DNA origami – DNA varieties: A, B, and Z – Applications of DNA nanostructures.

UNIT III PROTEIN AND ENZYME NANOPARTICLES 12

Proteins: Structure, classification and functions – Protein nanoparticles: Designing, synthesis strategy, ligands used and their applications – Enzymes and Enzyme nanoparticles:properties, structure:Preparation, immobilization, kinetic properties and applications of enzyme nanoparticles in day-day to life– Synzymes, ribozymes.

UNIT IV CARBOHYDRATESAND GLYCO NANOPARTICLES 12

Properties and Function of Carbohydrates– Sugars: disaccharides, trioses, tetroses, pentoses, hexoses – Stereoisomers - Aminosugars, phosphosugars, sugar derivatives, deoxysugars – Oligosaccharides –Polysaccharides - Homo and hetero polysaccharides, amylose, amylopectin, dextrans – starch –Glycogen: synthesis and degradation-glycolysis, TCA cycle, glycosyl moieties, cell wall polysaccharides – cellulose, chitin; Preparation of glyconanoparticles – Applications.

UNIT V LIPIDSAND LIPID BASED NANOPARTICLES 12

Structure, function and significance of lipids and membrane transport–Membranous nanostructures and their role in cellular traffic –Different types of lipid nanostructures: Preparation, applications – Lipid-based nanomaterials-Lipid-polymer nanoparticles and solid lipid nanoparticles–.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Comprehend the nanoscale phenomenon associated with cellular nanostructures
CO2: To reveal the nature of DNA nanostructures like DNA bricks, aptamers and origami
CO3: Design and utilize protein and enzyme based nanostructures
CO4: Classify glycol nanostructures based on their binding ligands
CO5: Have knowledge about membranetransportandmembrane based nanostructures and their uses

REFERENCES:

1. Barnard, Amanda S., and HaiboGuo, eds. Nature's Nanostructures. CRC Press, US, 2012.
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20. Gordillo-Galeano, Aldemar, and Claudia Elizabeth Mora-Huertas. "Solid lipid nanoparticles and nanostructured lipid carriers: A review emphasizing on particle structure and drug release." European Journal of Pharmaceutics and Biopharmaceutics 133 (2018): 285-308.

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Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	. Comprehend the nanoscale phenomenon associated with cellular nanostructures	3			3		2
CO2	To reveal the nature of DNA bricks, aptamers and origami	3			3		2
CO3	Design and utilize the protein and enzyme based nanostructuers	3			3		2
CO4	Classify glycol nanostructures based on their binding ligands	3			3		2
CO5	Have knowledge about membrane transport and membrane based nanostructures and their uses	3			3		2
	Overall CO	3			3		2

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN 6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS 6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, Business Research Methods, Tata McGraw Hill Education, 11e (2012)
2. Intellectual property: patents, trademarks, copyrights, trade secrets. By Catherine J. Holland. Entrepreneur Press, 2007
3. Patent searching: tools & techniques. By David Hunt, et al. Wiley, 2007.

4. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September 2013

NT4111 COMPUTATION AND SIMULATION LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To Acquire knowledge on various scientific modelling and simulation techniques.
- To Understand various syntax and command code for wide used modelling and simulation softwares.
- To Acquire knowledge to theoretically simulate the physical and chemical properties of various nanomaterials based on available data

1. Numerical programme to plot the first four Eigen functions of a one - dimensional rectangular potential well with infinite potential barrier.
2. Numerical solution of the Schrodinger wave equation for a rectangular potential well with infinite potential barrier using numerical programme.
3. Toy model in molecular electronics: IV characteristics of a single level molecule
4. To determine the lattice constant and lattice angles for atomically resolved STM image of HOPG (Highly Oriented Pyrolytic Graphite using offline Scanning Probe Imaging Processor (SPIP) Software.
5. To determine the surface roughness of raw and processed AFM images of glass, silicon and films made by different methods using offline SPIP software.
6. Simulation of I-V Characteristics for a single Junction circuit with a single quantum Dot using MOSES 1.2 Simulator.
7. Study of Single Electron Transistor using MOSES1.2 Simulator.
8. Simple Mathematical Operation – Basic Command in MATLAB – 2D lot – 3D plot – curve fitting interpolation – Simulink – introduction – physics with Simulink
9. Equations modelling for circular motion – circular motion in Simulink – electronics in Simulink – introduction to logic gates – logical gates in Simulink

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Gaining knowledge on modeling and simulation of equations using MATLAB
CO2: cquiring knowledge on image processing and analysis
CO3: Able to interpret the TEM, STEM and AFM images

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Gaining knowledge on modeling and simulation of equations using MATLAB			3		3	
CO2	Acquiring knowledge on image processing and analysis			3		3	
CO3	Able to interpret the TEM, STEM and AFM images			3		3	
	Overall CO			3		3	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4112 NANOMATERIALSYNTHESIS LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To train research skills and methodology for novel chemical, physical and biological synthesis and processing approaches of nanomaterials

LIST OF EXPERIMENTS

1. Chemical synthesisofAgnanoparticles;UV-Visibleabsorptionofthecolloidalsol;Mie formalism; Estimation of size by curve fitting
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap
3. Estimation from the band edge
4. Aqueous to organic phase transfer of Ag and CdS nanoparticles;Confirmationby UV- Visible absorption
5. Microwave assisted polymerization synthesis of ZnO nanowires
6. Sol gel synthesis of metal oxide(ZnO,TiO_2,CdO) nanoparticles:
7. Sol-gel spin coating route to SnO_2 nano thin films: surface roughness measurement by AFM
8. Electro spraying route to carbon nanofibers:surface morphology by SEM
9. Hydrothermal synthesis of ZnS Nano rods:Nano rods formation by SEM analysis
10. Mechanical ball milling technique to oxide ceramics preparation: crystallite size measurement by XRD

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Thorough hands on training and knowledge and skills on Nano materials synthesis using various chemical and physical methods
CO2: Able to synthesis metal oxide nanomaterials by bottom up synthesis method
CO3: Able to synthesis metal oxide nanomaterials by top down method

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Thorough hands on training and knowledge and skills on Nano materials synthesis using various chemical and physical methods			3		3	
CO2	Able to synthesis metal oxide nanomaterials by bottom up synthesis method			3		3	
CO3	Able to synthesis metal oxide nanomaterials by top down method			3		3	
	Overall CO			3		3	

SEMESTER II

NT4201 IMAGING TECHNIQUES FOR NANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVE

- This course introduces the student to the most important techniques available for micro and nano- materials characterization necessary for the development of micro- and nano- manufacturing

UNIT I OPTICAL MICROSCOPY 9

Concept of resolution and depth of field/focus in imaging, types of aberrations (spherical, chromatic, diffraction and astigmatism), Optical microscopy (OM) – reflected/transmitted light microscopy, theoretical and practical resolution of an optical microscope, numerical aperture, principles of image formation, dark field, polarized light and phase contrast microscopy and applications of each in metallurgical and materials engineering, sample preparation for optical microscopy and limitations.

UNIT II SCANNING ELECTRON MICROSCOPY 9

Advantages/disadvantages as compared to OM and other imaging techniques, mechanics of SEM, types of electron gun and comparison between them (in terms of resolution, brightness, efficiency and applications), SEM, its working and construction, concept of magnification as applied to SEM, electron-matter interaction, imaging modes (secondary and backscattered), effect of spot size, apertures, accelerating voltage on SEM imaging, signal detection (by using Everhart- Thornley, Robinson and solid state detectors), atomic number and topological contrast, critical probe current, chemical analysis of phases using SEM (EDS).

UNIT III TRANSMISSION ELECTRON MICROSCOPY 9

Principles of transmission electron microscopy - Modes of operation – construction, ray-diagram, working, sample preparation – contrast mechanisms (mass-thickness, phase and diffraction contrast), imaging modes, Diffraction in imperfect crystals – HRTEM use in nanostructures.

UNIT IV ATOMIC FORCE MICROSCOPY 9

Basic concepts-Interaction force-AFM and the optical lever- AFM tip on nanometer scale structures- force curves, measurements and manipulations-feedback control-different modes of operation –contact, non contact and tapping mode-Imaging and manipulation of samples in air or liquid environments-Imaging soft samples. Scanning Force Microscopy-types -Magnetic Force microscopy.

UNIT V SCANNING TUNNELING MICROSCOPY 9

Principle- Instrumentation- importance of STM for surface and molecular manipulation, 3D map of electronic structure.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Upon completion of the course, the students will be able to: - describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy

CO2: Explain the production of x-rays, electrons and the electron-specimen interaction mechanisms

CO3: Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the micro and nano-scale

REFERENCES

1. J. Goldstein, D. Newbury, D. Joy, C. Lyman, P. Echlin, E. Lifshin, L. Sawyer and J. Michael, “Scanning Electron Microscopy and X-ray Microanalysis” 3rd Edition, Springer Science, Berlin 2003.
2. Ray Egerton: “Physical Principles of Electron Microscopy” Springer Science, Berlin, 2005.
3. D. Brandon and W. Kaplan: “Microstructural Characterization of Materials”, John Wiley and Sons, London, 2008.
4. Douglas B. Murphy : "Fundamentals Of Light Microscopy And Electronic Imaging", John Wiley and Sons, London, 2001

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Upon completion of the course, the students will be able to: describe fundamental principles of operation of four materials characterization techniques, namely optical microscopy, scanning electron microscopy, transmission electron microscopy and scanning probe microscopy	3	3		3		
CO2	Explain the production of x- rays, electrons and the electron-specimen interaction mechanisms	3	3		3		
CO3	Select appropriate characterization methods to the analysis and characterization of materials and apply the microstructural characterization techniques to the analysis of materials at the micro and nano- scale	3	3		3		
	Overall CO	3	3		3		

NT4202 PHYSICOCHEMICAL CHARACTERIZATION OF NANOMATERIALS L T P C
3 0 0 3

OBJECTIVES

- To learn advanced analytical method used to study nanomaterials.
- To know about qualitative and quantitative analysis techniques employed for studying nanomaterials.
- To understand the mechanical analytical techniques used to study nanomaterials.

UNIT I SPECTROSCOPIC TECHNIQUES 9

Introduction to Molecular Spectroscopy and Differences-With Atomic Spectroscopy-Infrared (IR) Spectroscopy and Applications- Microwave Spectroscopy- Raman Spectroscopy and CARS Applications-Electron Spin Resonance Spectroscopy; NMR Spectroscopy; Dynamic Nuclear Magnetic Resonance; Dynamic light scattering (DLS), Double Resonance Technique.

UNIT II DIFFRACTION METHODS 9

X-ray powder diffraction – single crystal diffraction techniques - Determination of accurate lattice parameters - structure analysis -profile analysis - particle size analysis using Scherer formula - electron and neutron diffractions

UNIT III THERMAL ANALYSIS METHODS 9

Principle and Instrumentation of Thermogravimetry; Differential Thermal Analysis and Differential scanning calorimetry-Importance of thermal analysis for nanostructures.

UNIT IV QUALITATIVE AND QUANTITATIVE ANALYSIS 9

Electron Energy Loss Spectroscopy; High Resolution Imaging Techniques, Atom probe field ion microscopy-X-Ray Photoelectron Spectroscopy - X-ray fluorescence (XRF) -EDAX and WDA analysis – EPMA – ZAP corrections.

UNIT V NANOMECHANICAL ANALYSIS 9

Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in

small dimensions- models for interpretation of nanoindentation load displacement curves- Nanoindentation data analysis methods-Hardness testing of thin films and coatings- BET analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: Students will learn about advanced analytical techniques for nanomaterials

CO2: Students will learn about qualitative and quantitative analysis techniques employed for studying nanomaterials

CO3: Understand the mechanical analytical techniques used to study nanomaterials

REFERENCES:

1. B. D.Cullity, "Elements of X-ray Diffraction", 4th Edition, Addison Wiley, 1978.
2. M. H.Loretto, "Electron Beam Analysis of Materials", Chapman and Hall, 1984.
3. R.M.Rose, L.A.Shepard and J.Wulff, "The Structure and Properties of Materials", Wiley Eastern Ltd, 1996.
4. B.W.Mott, "Micro-Indentation Hardness Testing", Butterworths, London, 1956

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will learn about advanced analytical techniques for nanomaterials	3	3		3		
CO2	Students will learn about qualitative and quantitative analysis techniques employed for studying nanomaterials	3	3		3		
CO3	Understand the mechanical analytical techniques used to study nanomaterials	3	3		3		
Overall CO		3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4203 SYNTHESIS OF NANOMATERIALS L T P C
3 0 0 3

OBJECTIVES

- To explore the basic concepts and ideas involved in the synthesis of nanomaterials and to implement different strategies for synthesizing 0, 1D, 2D nanomaterials.
- To explore the role and application of nanomaterials in various fields.

UNIT I MECHANICAL ALLOYING AND MILLING 9

Introduction to synthesis of nanostructure materials, bottom-up approach and top-down approach– equipment for mechanical alloying, process variables in milling, Mechanism of alloying, Mechanochemical processing - Thermodynamic Aspects, Powder Contamination , Safety Hazards Related to Mechanical Alloying Processes.

UNIT II CHEMICAL APPROACHES 9

Sol gel method, Solvothermal and hydrothermal routes, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Self-assembled monolayers (SAMs), Langmuir-Blodgett (LB)

films, micro emulsion polymerization- Template based synthesis of nanomaterials- Electrochemical deposition, Electrophoretic deposition.

UNIT III PHYSICAL APPROACHES 9

Inert gas condensation technique – arc plasma and laser ablation, Vapor deposition and different types of epitaxial growth techniques (CVD,MOCVD, MBE,ALD)- pulsed laser deposition, Sputtering- Magnetron sputtering - Lithography :Photo/UV/EB/FIB techniques, Dip pen nanolithography, Etching process :Dry and Wet etching, micro contact printing.

UNIT IV NANOPOROUS MATERIALS 9

Zeolites and Mesoporous materials - Synthesis, properties and applications, Role of nanomaterials and nanomembranes in water purification - Carbon nanotubes and graphene - Core shell nanostructures and hybrid nanocomposites.

UNIT V APPLICATION OF NANOMATERIALS 9

Overview of nanomaterials properties and their applications, nanopaints, nano coating, nanomaterials for renewable energy, Nanoelectronics – Nanobots- Biological Applications.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: At the end of the course the student would Gain knowledge on the variou process techniques to synthesis nanostructured materials by clear understanding of growth controlling factors of nanomaterial

CO2: The students acquire knowledge about various kind of nanoporous materials

CO3: The course also gives clear knowledge on the application and implementation of nanomaterials to solve the societal problems

REFERENCES:

1. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and
2. Applications, Imperial College Press, London 2004.
3. T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGrawHill Publishing Company Limited NEW DELHI, 2007.
4. A S Edelstein and R C Cammarata, Nanomaterials Synthesis, Properties and Applications, IOP Publishing Ltd 1996.
5. Frank J. Owens and Charles P.Poole, The Physics and Chemistry of Nano Solids, Wiley-Interscience, 2008

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	. At the end of the course the student would Gain knowledge on the various process techniques to synthesis nanostructured materials by clear understanding of growth controlling factors of nanomaterials	3	3				3
CO2	The students acquire knowledge about various kind of nanoporous materials	3	3				3

CO3	The course also gives clear knowledge on the application and implementation of nanomaterials to solve the societal problems	3	3				3
Overall CO		3	3				3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4211 MATERIALS STRUCTURAL CHARACTERIZATION LABORATORY L T P C
0 0 4 2

OBJECTIVES

- To learn imaging techniques to study structural morphology of nanomaterials.
- To analysis the crystal structure and interpretation via XRD analysis

1. Determination of size and lateral dimensions of various samples (pollen grains, strands of hair) using a high magnification optical microscope.
2. SEM analysis of powder, thin films, porous materials
3. SEM interpretation of powder, thin films, porous materials
4. Surface topography analysis using AFM : powder, thin films, porous materials
5. Surface topography interpretation of powder, thin films
6. XRD analysis of powder sample.
7. XRD interpretation of powder samples: Determination of lattice parameters and crystallite size.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Will get experience in analysing the nanomaterials
CO2: Able to interpret SEM and AFM images
CO3: XRD interpretations of Nanopowders are gained and crystallanity can be analysed

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Will get experience in analysing the nanomaterials		3		3	3	
CO2	Able to interpret SEM and AFM images		3		3	3	
CO3	XRD interpretations of Nanopowders are gained and crystallanity can be analysed		3		3	3	
Overall CO			3		3	3	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4212 PHYSICOCHEMICAL CHARACTERIZATION LABORATORY L T P C
0 0 4 2

OBJECTIVES

- To learn spectroscopic analysis and interpretation of Nanostructures
- To fabricate the DSSC, supercapacitor and analyse the performance analysis

1. FTIR analysis of Nanostructures
2. FTIR interpretation of results
3. RAMAN Analysis of Nanostructures
4. RAMAN interpretation of results
5. TGA analysis of nanomaterials
6. TGA interpretation of results
7. DSC analysis of nanomaterials
8. DSC interpretation of results
9. UV-vis analysis of nanomaterials
10. UV-vis interpretation of nanomaterials
11. Preparation of CdS quantum dots loaded photoanode, fabrication of Quantum dot sensitized solar cells and performance analysis of the cell.
12. Preparation of GO and rGO, fabrication of an EDLC based electrode materials and electrochemical performance analysis of the electrode.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1: Students can able to analyze and interpret various spectroscopic techniques
CO2: Optical properties of QDs and graphene based materials can be analysed
CO3: Able to characterize the fabricated device and interpret the results

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students can able to analyze and interpret various spectroscopic techniques		3		3	3	
CO2	Optical properties of QDs and graphene based materials can be analysed		3		3	3	
CO3	Able to characterize the fabricated device and interpret the results		3		3	3	
Overall CO			3		3	3	

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4311 PROJECT WORK I L T P C
0 0 12 6

OBJECTIVES

The course aims to enable the students to

- identify the problem/process relevant to their field of interest that can be carried out
- search databases and journals to collect and analyze relevant data

- plan, learn and perform experiments to find the solution
- prepare project report

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

TOTAL : 180 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 Identify the research/industrial problems
CO2 Collect and analyze the relevant literature
CO3 Design, conduct experiment and analyse the data
CO4 Prepare project report

NT4312 INTERNSHIP L T P C
0 0 0 1

OBJECTIVE:

To train the students in the field work so as to have a firsthand knowledge of practical problems SYLLABUS: The students individually undertake training in reputed organizations/research institutes during the summer vacation for a specified duration of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

On completion of the course, the student would be able to
CO1: practically handle the machines in which he/she got trained
CO2: Generate and analyse
COE: Prepare technical report and present

NT4411 PROJECT WORK II L T P C
0 0 24 12

OBJECTIVES

The course aims to

- train students to analyze the problem/ think innovatively to develop new methods/product /process
- make them understand how to find solutions/ create products economically and in an environmentally sustainable way
- enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
- enable them to effectively think about strategies to commercialize the product .

TOTAL :360 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

COURSE OUTCOMES

At the end of the project the student will be able to
CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization

ELECTIVES

NT4001 LITHOGRAPHY AND NANOFABRICATION L T P C
3 0 0 3

OBJECTIVES

- To learn lithographic techniques.
- To obtain knowledge on nanofabrication of devices using lithography.

UNIT I SEMICONDUCTOR PROCESSING AND MICROFABRICATION 9

Introduction to semiconductor device processing - Necessity and different types of clean rooms-construction and maintenance of a clean room – Microfabrication process flow diagram – Chip cleaning, coating of photoresists, patterning, etching, inspection – Process integration - Etching techniques- Reactive Ion etching- RIE reactive ion etching- Magnetically enhanced RIE- IBE Ion beam etching.

UNIT II PHOTOLITHOGRAPHY AND PATTERNING OF THIN FILMS 9

Lithography -Optical lithography - different modes - Optical projection lithography - Multistage scanners – resolution and limits of photolithography – Resolution enhancement techniques - Photomask- Binary mask- Phase shift mask - Attenuated phase shift masks - alternating phase shift masks - Off axis illumination- Optical proximity correction - Sub resolution assist feature enhancement-Optical immersion lithography

UNIT III DIRECT WRITING METHODS-MASKLESS OPTICAL LITHOGRAPHY 9

Maskless optical projection lithography – types, Advantages and Limitations – required components - Zone plate array lithography - Extreme ultraviolet lithography – Light sources - Optics and materials issues

UNIT IV ELECTRON BEAM LITHOGRAPHY (EBL), X-RAY AND ION BEAM LITHOGRAPHY 9

Scanning electron-beam lithography- Electron sources, and electron optics system mask less EBL- parallel direct-write e-beam systems-electron beam projection lithography - Scattering with angular limitation projection e-beam lithography (SCALPEL) – Projection reduction exposure with variable axis immersion lenses. XRPP - Ion beam lithography- Focusing ion beam lithography - Ion projection lithography.

UNIT V NANOIMPRINT LITHOGRAPHY AND SOFT LITHOGRAPHY 9

Nanoimprint lithography (NIL)- NIL - hot embossing - UV-NIL- Soft Lithography- Moulding/Replica moulding: PDMS stamps - Printing with soft stamps- Edge lithography - Dip-Pen Lithography-set up and working principle – Self-assembly – LB films – Rapid prototyping.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Will realize the importance of miniaturization and nanofabrications

CO2: Will learn about various types of lithographic techniques

CO3: The students will able to understand the merits and de-merits of each lithographic techniques used for nanofabrication

REFERENCES:

1. Chris Mack, Fundamental Principles of Optical Lithography: The Science of Microfabrication, Wiley, 2008.
2. D. S. Dhaliwal et al., PREVAIL –“Electron projection technology approach for next generation lithography”, IBM Journal Res. & Dev. 45, 615 (2001).
3. M. Baker et al., “Lithographic pattern formation via metastable state rare gas atomic beams”, Nanotechnology 15, 1356 (2004).
4. H. Schift et al., “Fabrication of polymer photonic crystals using nanoimprint lithography”, Nanotechnology 16, 261, (2005).
5. R.D. Piner, “Dip-Pen” Nanolithography, Science 283, 661 (1999).

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Will realize the importance of miniaturization and nanofabrications	3	3	2	3		
CO2	Will learn about various types of lithographic techniques	3	3	2	3		
CO3	The students will able to understand the merits and de- merits of each lithographic techniques used for nanofabrication	3	3	2	3		
Overall CO		3	3	2	3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4002 NANOCOMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- To learn about Fundamentals aspects of nanocomposites and explore the fabrication technologies of nanocomposites.
- To elucidate on advantages of nanotechnology based applications in each industry.

UNIT I BASICS OF NANOCOMPOSITES 9

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS 9

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY 9

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: The students will learn about fundamental aspects and fabrication technologies of nanocomposites

CO2: Will gain knowledge about applications of nanocomposites in various industries

CO3: At the end of this course students would be able to design, build nanocomposite materials for engineering applications

REFERENCES:

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	The students will learn about fundamental aspects and fabrication technologies of nanocomposites	3	3		3		
CO2	Will gain knowledge about applications of nanocomposites in various industries	3	3		3		
CO3	At the end of this course students would be able to design, build nanocomposite materials for engineering applications	3	3		3		
Overall CO		3	3		3		

NT4003 NANOELECTRONICS AND SENSORS L T P C
3 0 0 3

OBJECTIVES:

- To learn about overview of nanoelectronics.
- To study the basic components of electronic systems.
- To learn about sensor fabrication and applications.

UNIT I OVERVIEW OF NANO-ELECTRONICS 9

Nano-scale electronics; Foundation of nano-electronics – low dimension transport, quantum confinement, Coulomb blockade and quantum dot; Ballistic transport and Quantum interferences; Landauer formula, quantization of conductance, example of Quantum point contact.

UNIT II TWO-TERMINAL JUNCTION TRANSISTORS 9

Basic CMOS process flow; MOS scaling theory; Issues in scaling MOS transistors; Requirements for non-classical MOS transistor; PMOS versus NMOS; Design and construction of MOS capacitor; Integration issues of high-k MOS – interface states, bulk charge, band offset, stability, reliability; MOS transistor and capacitor characteristics.

UNIT III GATE 9

Metal gate transistors – motivation, basics and requirements; quantum transport in nanoMOSFET; Ultrathin body silicon on insulator (SOI) – double gate transistors; Vertical transistors – FinFET and surround gate FET; compound semiconductor MOSFET –Hetero-structures MOSFET.

UNIT IV SENSORS AND ACTUATOR CHARACTERISTICS 9

Basic types and working principles of sensors and actuators; Characteristic features: Range, Resolution, Sensitivity, Error, Repeatability, Linearity and Accuracy, Impedance, Nonlinearities, Static and Coulomb Friction, Eccentricity, Backlash, Saturation, Deadband, System Response, First Order System Response, Under-damped Second Order System Response, Frequency Response.

UNIT V MEMORY DEVICES AND SENSORS 9

Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemicalcells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductorgas sensors –electronic noses – identification of hazardous solvents and gases –semiconductor sensor array.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: Students will gain knowledge in basics of nanoelctronics

CO2: Students will gather idea about materials and techniques used for sensor components

CO3: Students will acquire information about fabrication of different sensors

REFERENCES

1. W. Ranier, “Nano Electronics and Information Technology”, Wiley, (2003).
2. K.E. Drexler, “Nano systems”, Wiley, (1992).
3. M.C. Petty, “Introduction to Molecular Electronics”1995.
4. Vladimir V. Mitin, Vieatcheslov A. Kochelap, Micheal A. Stroscio, Introduction to Nanoelectronics, Cambridge University Press, London, 2008
5. Vinod Kumar Khanna, Nanosensors:Physical, Chemical and Biological, CRC Press, London, 2014
6. Supriyo Datta, Lessons from Nanoelectronics, World Scientific, Hong Kong, 2012

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will gain knowledge in basics of nanoelctronics	3	3	2	3		
CO2	Students will gather idea about materials and techniques used for sensor components	3	3	2	3		
CO3	Students will acquire information about fabrication of different sensors	3	3	2	3		
Overall CO		3	3	2	3		

NT4004 NANOTECHNOLOGY IN AGRICULTURE AND FOOD INDUSTRY L T P C
3 0 0 3

OBJECTIVES:

- To study the basic interaction of different molecules which are helpful in both food and agricultural activities
- To understand the importance of nanomaterials and devices in precision farming, advanced materials used in agriculture and food industries.

UNIT I NANOTECHNOLOGY IN CROP PRODUCTION 9

Fertilizer – types and mode of action; Nanofertilizer – nanourea and mixed fertlizers; Nanomaterials as soil conditioners – zeolites, nanoclays, superabsorbent polymers, nanocomposites; Nanoemulsion based antitranspirants; Nanosensors for monitoring soil moisture; Effect of nanoparticles in seed – carbon based, TiO_2, aluminium, silver, copper, ZnO nanoparticles; Smart delivery systems for nanofertilizer release;

UNIT II NANOTECHNOLOGY IN PEST MANAGEMENT 9

Introduction to pest management; nanomaterials for pest management; Nanoherbicide, nanopesticide and nanofungicide- its application, mode of action and evaluation; nanoparticles and mesoporous nano materials for smart delivery; Nanosensors for pest management; Assessment of efficacy and safety on nontarget organisms;

UNIT III NANOTECHNOLOGY IN FOOD PROCESSING 9

Introduction and scope; Nanobased smart delivery system for nutraceuticals and its release mechanism; Nano cochleates – formulation methods and mechanism of release; Nanoclusters; Nanolaminates- properties, preparation and application; Nanoemulsions – preparation and application; Nanoencapsulation technology- materials used, principle, release mechanism and advantages;

UNIT IV NANOTECHNOLOGY IN FOOD PACKAGING 9

Nanocomposites; Nanostructured layers; Nanomaterials for food preservation; Nanopackaging for enhanced shelf life; Nanotechnology in intelligent packaging; Nanosensors for food safety monitoring.

UNIT V IMPACTS OF NANOAPPLICATION 9

Nanoparticles – mode of action, bioaccumulation and its interaction with biological systems; Fate of nanoparticles in the environment; Health hazards of nanomaterials in the workplace; Nanoethics, safe handling and precautionary protocol.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Student will learn the basic interaction of different molecules which are helpful inboth food and agricultural activities

CO2: Understand the importance of nanomaterials and devices in precision farming

CO3: Students will understand the importance of advanced materials used in agriculture and food industries

REFERENCES:

1. C.R.Chinnamuthu, B. Chandrasekaran C. Ramasamy- Nanotechnology Applications in Agriculture, 2008.
2. S.Choudary, Applied Nanotechnology in Agriculture. Arise Publications.ISBN:978-93-80162-54-6, 2011
3. Jain, P., S.Arora and T.Rai,. - Flavour encapsulation and its application, Beverage and Food World 24 (4), 21-24, 1997
4. Günter Oberdörster, Eva Oberdörster, Jan Oberdörster. 2005. NANOTOXICOLOGY: An Emerging Discipline Evolving from Studies of Ultrafine Particles Environ Health Perspect. July; 113(7): 823–839
5. Nancy A.Monteiro-Reviere and C.Lang Tran, Nanotoxicology-Charachterization, Dosing and Health Effects.Informa HealthCare, New York. 434p. 2009.
6. Monique A. V. Axelos (Editor), Marcel Van de Voorde (Editor), Nanotechnology in Agriculture and Food Science; ISBN: 978-3-527-69773-1; March 2017; 450p

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Student will learn the basic interaction of different molecules which are helpful inboth food and agricultural activities	3	3		3		
CO2	Understand the importance of nanomaterials and devices in precision farming	3	3		3		
CO3	Students will understand the importance of advanced materials used in agriculture and food industries	3	3		3		
	Overall CO	3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4005 NANOMATERIALS FOR ENERGY AND ENVIRONMENT L T P C
3 0 0 3

OBJECTIVES:

- To be aware of the challenges and demand for Energy
- To study about the nanomaterials used in Energy applications
- To enhance our knowledge on the role of nanomaterials in remediation applications and its impact on the environment.

UNIT I INTRODUCTION 9

Sustainable energy - Materials for energy - Green house effect - CO_2 emission - Energy demand and challenges.

UNIT II RENEWABLE ENERGY TECHNOLOGY 9

Development and implementation of renewable energy technologies. Nano, micro and mesoscale phenomena and devices. Energy conversion, transport and storage. High efficiency Photovoltaic solar cells. High performance thermoelectric systems - Integration and performance of DSSC-Quantum dots based solar cells.

UNIT III NANOMATERIALS IN FUEL CELL AND STORAGE TECHNOLOGY 9

Micro-fuel cell technologies, integration and performance for micro-fuel cell systems - thin film and microfabrication methods - design methodologies - micro-fuel cell power sources - Supercapacitors - Specific energy- charging/discharging - EIS analysis.

UNIT IV HYDROGEN STORAGE AND PHOTOCATALYSIS 9

Hydrogen storage methods - metal hydrides - size effects - hydrogen storage capacity - hydrogen reaction kinetics - carbon-free cycle- gravimetric and volumetric storage capacities - hydriding/dehydriding kinetics - multiple catalytic effects - degradation of the dye - nanomaterials based photocatalyst design - kinetics of degradation.

UNIT V ENVIRONMENTAL APPLICATIONS & IMPACTS OF NANOMATERIAL 9

Nanomaterials as adsorbents - Nanocomposite membrane systems for water remediation: Membrane fabrication; Membrane reactors & Active Membrane systems -Ecotoxicological impacts of nanomaterials - Lifecycle assessment of nanomaterials.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will gain familiarity with renewable energy technologies updated with nano devices and different fabrication methodologies

CO2: Kinetic studies of dye degradation using nanophotocatalysts will be learned

CO3: Students get acquainted with the application of nanomaterials and its impacts in environmental systems

REFERENCES:

1. J. Twidell and T. Weir, Renewable Energy Resources, Taylor & Francis Group, 2014 (4th Edition).
2. Ram B.Gupta, Hydrogen Fuel,CRC Press, Taylor and Francis Group, New York, 2009
3. Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, Taylor and Francis Group New York, 2003.
4. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London, 2003
5. Zhen Fang, Richard L Smith, Xinhua Qi, Production of Hydrogen from Renewable Resources, , Springer, London, 2016
6. Mark R. Wiesner, Jean-Yves Bottero, Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw Hill, New York, 2007.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will gain familiarity with renewable energy technologies updated with nano devices and different fabrication methodologies	3	3		3		
CO2	Kinetic studies of dye degradation using nanophotocatalyst s will be learned	3	3		3		
CO3	Students get acquainted with the application of nanomaterials and its impacts in environmental systems	3	3		3		
	Overall CO	3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4006 **NANO BIOPHOTONICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To learn about Fundamentals of light and optics
- To study the concepts of optical based imaging techniques.
- To learn about recent development in optical sensors.

UNIT I BASICS OF LIGHT AND OPTICS **9**

Interaction of light with cells, tissues, non-linear optical processes with intense laserbeams, photo-induced effects in biological systems.

UNIT II IMAGING TECHNIQUES **9**

Light microscopy, wide-field, laser scanning, confocal, multiphoton, fluorescence lifetimeimaging, FRET imaging, Frequency-Domain lifetime imaging. Cellular Imaging, Imagingof soft and hard tissues and other biological structures.

UNIT III SINGLE MOLECULE SPECTROSCOPY **9**

UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics –IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

UNIT IV OPTICAL FORCE SPECTROSCOPY **9**

Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems – single molecule biophysics, DNA protein interactions.

UNIT V SENSORS AND OPTICAL TECHNIQUES 9

Biosensors, fluorescence immuoassay, flow cytometry, Fluorescence correlation spectroscopy, Fluorophores as cellular and molecular tags.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students will gain knowledge in basics of optics

CO2: Students will gather idea about imaging techniques

CO3: Students will acquire information about Biophotonics and advanced optical sensors

REFERENCES:

1. Laser Tweezers in Cell Biology in Methods in Cell Biology, Vol.55, Michael P. Sheetz(Ed.), Academic Press 1997.
2. P.N. Prasad, Introduction to Biophotonics, John-Wiley, 2003.
3. G. Marriot & I. Parker, Methods in Enzymology, Vol.360,2003.
4. G. Marriot & I. Parker, Methods in Enzymology, Vol.361,2003.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will gain knowledge in basics of optics	3	3		3		
CO2	Students will gather idea about imaging techniques	3	3		3		
CO3	Students will acquire information about Biophotonics and advanced optical sensors	3	3		3		
	Overall CO	3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4007 ADVANCED DRUG DELIVERY SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To learn about Fundamentals of drug delivery systems
- To study the materials and techniques used in Delivery systems
- To learn about Recent development in the area of devices and therapy.

UNIT I THEORY OF ADVANCED DRUG DELIVERY 9

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models.

UNIT II POLYMERS 9

Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscafold systems-Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA.

UNIT III LIPID BASED NANOCARRIERS 9

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes.

UNIT IV MICROBES AND ANTIBODY BASED NANOCARRIERS 9

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibody bioconjugates.

UNIT V DEVICES FOR DRUG DELIVERY 9

Fabrication and Applications of Microneedles, Micropumps, microvalves. Implantable microchips.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will gain knowledge in basics of drug delivery systems
CO2: Students will gather idea about materials and techniques used for drug coating and delivery
CO3: Students will acquire information about recent trends equipments and delivery systems

REFERENCES:

1. M. Salzman Drug Delivery: Engineering Principles for Drug Therapy, Oxford University Press, 2001.
2. A.M. Hillery, Drug Delivery and Targeting, CRC Press, 2002.
3. B. Wang, Drug Delivery: Principles and Applications, Wiley Intersceince, 2005.
4. Ram B. Gupta, Uday B. Kompella , Nanoparticle Technology for Drug Delivery, Taylor& Francis, 2006.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will gain knowledge in basics of drug delivery systems	3	3	2	3		
CO2	Students will gather idea about materials and techniques used for drug coating and delivery	3	3	2	3		
CO3	Students will acquire information about recent trends equipments and delivery systems	3	3	2	3		
	Overall CO	3	3	2	3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4008 PROCESSING AND PROPERTIES OF NANOSTRUCTURED MATERIALS L T P C
3 0 0 3

OBJECTIVES

- To learn basic material science with special emphasize on nanomaterials
- To know about processes in handling polymers and nanostructured materials.
- To understand various forms of nanomaterials and polymers for special applications.

UNIT I DEFORMATION PROCESSING AND METAL FORMING 9

Classification of engineering materials - Tensile testing – Stress strain curve – Flow stress -

Mechanical properties – Formability - Deformation processes - Mechanics of metal working – Metal forming - forging, rolling, extrusion, wire drawing – Superplastic forming – Bulk nanostructured materials by Severe Plastic Deformation (SPD) - Comparison of processes.

UNIT II MICROSTRUCTURAL PROPERTIES 9

Defects in solids – classifications of defects – Microstructure – grain size, grain boundary, effects of processing and defects – Processing, microstructure, properties correlations – Mechanical Properties and processing - grain size evolution and grain size control; Hall Petch relation-strengthening mechanisms; work hardening - grain boundary strengthening – solid solution strengthening – precipitation hardening - effects of diffusion on strength and flow of materials .

UNIT III PROCESSING OF POLYMERS 9

Engineering plastics – Pellets and sheets – Glass transition temperature of polymers –Melt flow index – Polymer processing tools and process conditions - injection moulding, thermoforming, vacuum and pressure assisted forming.

UNIT IV PROCESSING OF POWDERS OF METALS AND CERAMICS 9

Metal/Ceramic Powder synthesis - Selection and characterization of powders – compacting and sintering - Production of Porous and Dense Composite Components: Advanced composite materials - Metal- polymer- and ceramic- based composites and their properties – Fabrication of composite materials.

UNIT V PROCESSING OF FUNCTIONAL NANOMATERIALS 9

Properties of nanocrystalline materials required for structural, energy, environmental, textile and catalytic applications; processing techniques; techniques for retaining the nanocrystalline structure in service. Pervoskite structures, catalytic applications.

TOTAL :45 PERIODS

COURSE OUTCOMES:

CO1: Will acquire knowledge about the deformation and microstructural properties of the nanomaterials

CO2: Gaining knowledge about processes of polymers and nanostructured materials

CO3: Will understand the functional properties of nanomaterials and polymers for various applications

REFERENCES

1. H. Cottrell “The Mechanical Properties of Matter”, John Wiley, New York, 1964.
2. R. Asthana, A. Kumar and N. Dahotre “Materials Science in Manufacturing” Butterworth Heinemann, Elsevier 2006.
3. G. E. Dieter, adapted by D Bacon, “Mechanical Metallurgy”, McGraw Hill, Singapore, 1988.
4. K. A. Padmanabhan, “Mechanical Properties of Nanostructured Materials”, Materials Science and Engineering, A 304-306 (2001) 200-205.
6. H. Gleiter, “Nanocrystalline Materials”, Progress in Materials Science Vol. 33,
7. C. Koch, “Nanostructured Materials: Processing, Properties and Applications”, 2nd Edition, Ed.: 2007

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Will acquire knowledge about the deformation and microstructural properties of the nanomaterials	3	3		3		3

CO2	Gaining knowledge about processes of polymers and nanostructured materials	3	3		3		3
CO3	Will understand the functional properties of nanomaterials and polymers for various applications	3	3		3		3
Overall CO		3	3		3		3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4009 MEMS AND NEMS L T P C
3 0 0 3

OBJECTIVES:

- To learn about Micro fabrication and scaling of MEMS
- To study the Microsystem and materials used in MEMS Technology
- To learn about Biological MEMS Technology

UNIT I MEMS MICROFABRICATION 9

Historical Development of Microelectronics, Evolution of Microsensors, Evolution of MEMS, Emergence of Micromachines, Modeling - Finite Element Analysis, CAD for MEMS, Fabrication – ALD, Lithography Micromachining, LIGA and Micromolding, Saw-IDT Microsensor Fabrication, Packaging – Challenges, Types, Materials and Processes.

UNIT II SCALING OF MEMS 9

Introduction to Scaling Issues, Scaling effects on a cantilever beam, Scaling of electrostatic actuators, Scaling of thermal actuator, Scaling of Thermal Sensors, mechanics and electrostatistics. Influence of scaling on material properties.

UNIT III MICROSYSTEMS 9

Microsensors, microaccelerometer, microfluidics, Mechanics for Microsystems design-Thermomechanics, fracture mechanics, thin film mechanics. Microfluid mechanics.

UNIT IV MATERIALS FOR MEMS 9

Materials for mems and pro mems-silicon-metals and polymers-Substrate Materials for MEMS-Silicon-quartz-ceramics-Bulk metallic glasses-Sharp Memory alloys, Carbon based MEMS

UNIT V COMMERCIAL AND TECHNOLOGICAL TRENDS 9

Commercial trends in miniaturization – High density chip analysis-Micro-accelerometers micro-resonators-lab-in-chip for DNA and protein analysis – Nano HPLC system nanopatches.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students would gain knowledge in microfabrication techniques and scaling process

CO2: Would acquire knowledge about the Microsystem and materials used in MEMS Technology

CO3: Students would acquire information about recent trends in MEMS and BioMEMS techniques

REFERENCES:

1. Marc Madou, Fundamentals of Microfabrication, CRC Press 1997.
2. MEMS and Microsystems design and manufacture, Tai-Ran Hsu,Tata Mc Graw Hill2011.

3. Sergey Edward Lyshevski, Nano- and Microelectromechanical Systems, CRC Press2000.
4. Vijay Varadan, Xiaoning Jiang, and Vasundara Varadan, Microstereo lithography *and* other Fabrication Techniques for 3D MEMS*,* Wiley 2001.
5. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, McGraw-Hill 2001.
6. Ken Gilleo. MEMS/MOEMS Packaging: Concepts, Designs, Materials and Processes. McGraw-Hill, 2005.

Course Articulation Matrix:

Course Outcomes	Statement	Programme					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students would gain knowledge in microfabrication techniques and scaling process	3	3		3		
CO2	Would acquire knowledge about the Microsystem and materials used in MEMS Technology	3	3		3		
CO3	Students would acquire information about recent trends in MEMS and BioMEMS techniques	3	3		3		
Overall CO		3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4010 SEMICONDUCTOR NANOSTRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- To gain knowledge about basic semiconductor metals & its characteristics
- To know the physical & quantum aspects of semiconductor
- To obtain a basic idea about energizing material & its effects

UNIT I SEMICONDUCTOR FUNDAMENTALS 9

Introduction to Semiconductor physics – Fabrication techniques – Semiconductor nanostructures – Electronic structure and physical process – Principles of semiconductor nanostructures based electronic and electro-optical devices – Semiconductor Quantum Dots – Quantum Lasers – Quantum Cascade Lasers – Quantum Dot Optical Memory.

UNIT II SEMICONDUCTOR NANOPARTICLE SYNTHESIS 9

Cluster compounds, quantum-dots from MBE and CVD, wet chemical methods, reverse micelles, electro-deposition, pyrolytic synthesis, self-assembly strategies.

UNIT III PHYSICAL PROPERTIES 9

Melting point, solid-state phase transformations, excitons, band-gap variations-quantum confinement, effect of strain on band-gap in epitaxial quantum dots, single particle conductance.

UNIT IV SEMICONDUCTOR NANOPARTICLES – APPLICATIONS 9

Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles, carrier injection, polymer-nanoparticle, LED and solar cells, electroluminescence, barriers to nanoparticle lasers, doping nanoparticles, Mn-Zn-

Se phosphors, light emission from indirect semiconductors, light emission form Si nanodots.

UNIT V SEMICONDUCTOR NANOWIRES 9

Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Overall the students will get idea about basic and advanced concepts in electronics and quantum physics
CO2: Will acquire knowledge about the physical and quantum aspects of semiconductors
CO3: Students will acquire the ideas about optical applications of semiconductor nanostructures

REFERENCES:

1. Encyclopedia of Nanoscience and Nanotechnology- Hari Singh Nalwa, 2004.
2. Springer Handbook of Nanotechnology - Bharat Bhusan, 2004.
3. Handbook of Semiconductor Nanostructures and Nanodevices Vol 1-5- A. A.Balandin, K. L. Wang 2006.
4. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao,Guozhong, 2011.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Overall the students will get idea about basic and advanced concepts in electronics and quantum physics	3	3		3		
CO2	Will acquire knowledge about the physical and quantum aspects of semiconductors	3	3		3		
CO3	Students will acquire the ideas about optical applications of semiconductor nanostructures	3	3		3		
	Overall CO	3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4011 NANOTOXICOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To make students learn various concepts of toxicity, and its effects.
- To help them gain knowledge about the toxicity in Nanoscience, and their effects on Human.
- To enhance knowledge on the nanotoxicology - prevention and remedies.

UNIT I INTRODUCTION TO TOXICOLOGY 9

Concept of Toxicology-Types of toxicity based on route of entry, nature of the toxin.Toxicodynamics–Dose vs Toxicity Relationships. Toxico kinetics – ADME, LADMET hypothesis. Genotoxicity and carcinogenicity – Mechanisms and Tests. Organ toxicity – Respiratory**,** dermal, hepato, neuro and nephro.

UNIT II NANOTOXICOLOGY 9

Characteristics of Nanoparticles that determine Potential Toxicity. Bio-distribution ofnanoparticles. Interation of Nanoparticles with Biomembrane and genes. Evaluation ofNanoparticle transfer using placental models. Nanomaterial toxicity – Pulmonary**,** dermal,hepato, neuro, ocular and nephro; Estimation of Nanoparticle Dose in Humans.In vitro toxicity studies of ultrafine diesel exhaust particles; Toxicity studies of carbon nanotubes

UNIT III PROTOCOLS IN TOXICOLOGY STUDIES 9

Methods for toxicity assessment – Cyto, Geno, hepato, neuro, nephrotoxicity. Assessment of toxicokinetics. Assessment of oxidative stress and antioxidant status.

UNIT IV ANIMAL MODELS 9

Types, species and strains of animals used in toxicity studies. Dosing profile for animalmodels. Studies on toxicology, pathology and metabolism in mouse and rat. Laws andRegulations Governing Animal Care and Use in Research.

UNIT V RISK ASSESSMENT AND EXECUTION 9

SRisk assessment of Nanoparticle exposure. Prevention and control of nanoparticles exposure. Regulation and recommendations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will get knowledge on nanotoxicology and their effects on human and animals
CO2: They will acquire knowledge about various prevention methods
CO3: Gaining knowledge on the remedies for nanotoxicology

REFERENCES:

1. John H. Duffus, Howard G. J. Worth, 'Fundamental Toxicology', The Royal Society of Chemistry 2006.
2. Nancy A. Monteiro-Riviere, C. Lang Tran., 'Nanotoxicology: Characterization, Dosing and Health Effects',Informa Healthcare publishers, 2007.
3. Lucio G. Costa, Ernest Hodgson, David A. Lawrence, Donald J. Reed,William F.Greenlee 'Current Protocols in Toxicology', John Wiley & Sons, Inc. 2005.
4. Shayne C. Gad, 'Animal models in toxicology', Taylor & Francis Group, LLC 2007.
5. P. Houdy, M. Lahmani, F. Marano, 'Nanoethics and Nanotoxicology', Springer- Verlag Berlin Heidelberg 2011.
6. A Reference handbook of nanotoxicology by M.ZafarNyamadzi 2008.
7. Andreas Luch, 'Molecular, Clinical and Environmental Toxicology Volume 2: ClinicalToxicology', BirkhauserVerlag AG 2010.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will get knowledge on nanotoxicology and their effects on human and animals	3	3		3		
CO2	They will acquire knowledge about various prevention methods	3	3		3		

CO3	Gaining knowledge on the remedies for nanotoxicology	3	3		3		
Overall CO		3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4012 NANOTECHNOLOGY IN HEALTH CARE L T P C
3 0 0 3

OBJECTIVES

- To be introduced to recent advancements in nano medicine.
- To learn about nano diagnostics.
- To learn developments in nanostructured materials used for medical implants.

UNIT I TRENDS IN NANOBIOTECHNOLOGY 9

Nanotechnology in gene therapy. Stem Cell technology. PCR, ELISA, DNA Profiling and Blotting techniques-Nanoprobes.

UNIT II NANOIMMUNOTECHNOLOGY 9

Nanoimmuno assay and nano-immuno sensors- Bio-Barcode Assay- use of magnets, gold, DNA and antibodies. Immunodiagnostics for cancer and central nervous system disorders.

UNIT III NANOTECHNOLOGY BASED MEDICAL DIAGNOSTICS 9

Improved diagnosis by i*n vivo* imaging - detection of tumors, plaque and genetic defects. Nanobot medical devices. Cantilever Sensors.

UNIT IV PROSTHETIC AND MEDICAL IMPLANTS 9

Prosthesis and implants. neural, ocular, cochlear, dental implants. implants and prosthesis of skin, limb, bone. Artficial organ and Organ transplant. Nano fibre scaffold technology.

UNIT V BIOMEDICAL APPLICATIONS OF NANOTECHNOLOGY 9

Nano-bioconjugates and their significance. Nanoscaffolds. Magnetic Nanoparticles. Multifunctional Inorganic and organic nanoparticles and their biomedical applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Comprehend the nanoparticles-based gene therapy, nanoprobing and profiling techniques and their application
CO2: Understand the use of metal nanoparticles and antibodies in diagnosis of biomarkers with high sensitivity
CO3: Be aware of the principle and uses of cantilever sensors and imaging of plaques and tumors
CO4: Completely understand the ocular, cochlear, dental implants and nanofiber technology
CO5: Have knowledge on functionalised nanoscaffolds, magnetic, organic and inorganic nanoparticles

REFERENCES:

1. Brian, R Eggins, Chemical Sensors and Biosensors; Wiley; New York, 2002.
2. 2. L Gorton, Biosensors and modern biospecific analytical techniques, Wilson & Wilson's Comprehensive Analytical Chemistry Elsevier, Amsterdam, London; 2005.
3. David Wild; The Immunoassay Handbook; 3rd ed.; Amsterdam: Elsevier; 2005.
4. Allen J Bard and LarryR Faulkner;Electrochemical Methods: Fundamentals and Applications; Wiley, New York, 2nd ed.; 2001.
5. Vladimir M. Mirsky, Ultrathin Electrochemical Chemo- and Biosensors: Technology and Performance in Springer Series on Chemical Sensors and Biosensors; Springer, Berlin; 2004

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Comprehend the nanoparticles- based gene therapy, nanoprobing and profiling techniques and their application	3	3		3		
CO2	Understand the use of metal nanoparticles and antibodies in diagnosis of biomarkers with high sensitivity	3	3		3		
CO3	Be aware of the principle and uses of cantilever sensors and imaging of plaques and tumors	3	3		3		
CO4	Completely understand the ocular, cochlear, dental implants and nanofiber technology						
CO5	Have knowledge on functionalised nanoscaffolds, magnetic, organic and inorganic nanoparticles						
	Overall CO	3	3		3		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

NT4013 **NANO BIOSENSORS** **L T P C**
3 0 0 3

OBJECTIVES:

- To learn about principles, components and fabrication of biosensors
- To study about various types of biosensors
- To learn about recent development and application of biosensor.

UNIT I ESSENTIALS OF BIOSENSORS **9**

General principle, component, characteristics. Types- Calorimetric Biosensor, Potentiometric Biosensor, Amperometric Biosensor, Optical Biosensor, Piezo-electric Biosensor. Detection systems. Techniques used for microfabrication -microfabrication of electrodes-on chip analysis.

UNIT II PROTEIN BASED BIOSENSORS **9**

Nano structure for enzyme stabilization – single enzyme nano particles – nano tubes microporus silica – protein based nano crystalline. Diamond thin film for processing.

UNIT III DNA BASED BIOSENSOR **9**

Heavy metal complexing with DNA and its determination, sensing in water and food samples – DNA zymo Biosensors.

UNIT IV SENSING OF CELLS AND PATHOGENS 9

Nanoscale biosensors. Nanobiosensors for cellular biosensing and sensing of rare cells. Detection of pathogens in food and water samples.

UNIT V APPLICATIONS OF BIOSENSORS 9

Designed protein pores and protein cages -as components of biosensors. Biosensors for pharma and medicine, bioremediation, defense and food technology, wearable biosensor.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will acquire knowledge in basics of Biosensors

CO2: Students will gain idea about fabrication techniques of biosensors

CO3: Students will gain information about recent trends in nanobiosensors and application in various fields

REFERENCES:

1. J.Cooper, C.Tass Biosensors: APractical Approach, Oxford Univ Press, 2004.
2. Cs. Kumar, Nanomaterials for Biosensors, , Wiley – VCH, 2007.
3. G.K. Knoff, A.S. Bassi, Smart Biosensor Technology, , CRC Press, 2006.

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will acquire knowledge in basics of Biosensors	3	3		3		
CO2	Students will gain idea about fabrication techniques of biosensors	3	3		3		
CO3	Students will gain information about recent trends in nanobiosensors and application in various fields	3	3		3		
	Overall CO	3	3		3		

NT4014 NANOTECHNOLOGY IN TISSUE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To learn about nanomaterials for tissue engineering
- To study about various types ofnanobiomaterials
- To learn about recent development and application of tissue engineering

UNIT I NANOMEDICINE AND TISSUE ENGINEERING 9

Relationship of Nanomedicine and Tissue Engineering, Nano drug Delivery Systems for Tissue Regeneration,

Synthesis of polymeric nano matrials for tissue engineering, Chitosan as Biomaterial for Tissue Engineering, Skeletal Tissue Engineering, Nanotechnology Approaches to Regenerative Engineering

UNIT II ELECTROSPINNING OF POLYMERS FOR TISSUEENGINEERING 9

Introduction, History of Electrospinning, Experimental Setup and Basic Principle, Effects of Parameters on Electrospinning, Biomedical Applications of Electrospun Nanofibers ,Cancer Detection and Diagnosis,Pharmaceutical Nanotechnology

UNIT III REGENERATION OF SENSORY SYSTEM 9

Biomaterials and Nanotechnology for Tissue Engineering: Neural Regeneration, Tissue Engineering Therapies for Ocular Regeneration, Bioartificial Pancreas, Progress in Tissue Engineering Approaches toward Hepatic Diseases Therapeutics Additive Manufacturing-Based Tissue Engineering, Laser-Assisted Bioprinting for Tissue Engineering, Translational Aspects of Tissue Engineering,Tissue-Engineered Medical Products

UNIT IV BIOMIMETIC NANOFIBERS FOR MUSCULOSKELETAL TISSUEENGINEERING 9

Structural and Functional Requirements for Musculoskeletal Tissues,Nanofibers as 3D Scaffolds for Tissue Regeneration, Extracellular Matrix Analogs for Cartilage Regeneration, Bioactive Nanofibers and Methods of Immobilizing Biomolecules,Gene Delivery Through Nanofibers, Techniques to Improve Porosity and Cell Infiltration on Nanofiber Scaffolds, Nanofiber Scaffolds for Interface Regeneration

UNIT V DERMAL TISSUE ENGINEERING: CURRENT TRENDS 9

Introduction, Nanotopography-Guided Skin Tissue Engineering, Stem Cells for Skin Tissue Engineering, Scarless Fetal Skin Wound Healing, Preparation of Self-Assembled Hydrogels, Hydrogels Characteristics for Cells, Self-Assembled Hydrogels, Significance of Natural and Synthetic Polymer for Hydrogels, Recent Development of Self-Assembled Hydrogel,Future of Nanotechnology in Tissue Engineering

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Students will acquire knowledge in basics of nanotechnology tissue engineering
CO1: Students will acquire knowledge of regeneration tissue engineering of sensory system
CO3: Students will gain information about recent trends in application of tissue engineering

REFERENCES:

1. By Swaminathan Sethuraman, Uma Maheswari Krishnan, Anuradha Subramanian, Biomaterials and Nanotechnology for Tissue Engineering, CRC Press Taylor & Francis,2020.
2. A,K. gaharwar, S.Sant, M.J. Hancock and S.A. Hacking, Nanomaterials in tissue engineering: Fabrication and applications, Woodhead Publishing, Oxford, 2013.
3. Sarah Afaq, Arshi Malik, Mohammed Tarique Application of Nanoparticles in Tissue Engineering springer verlag, Singapore, 2022,

. **Course Articulation Matrix:**

Course Outcomes	Statement	Program Outcome					
		PO1	PO2	PO3	PO4	PO5	PO6
CO1	Students will acquire knowledge in basics of nanotechnology tissue engineering	3	3		3		
CO2	Students will acquire knowledge of regeneration tissue engineering of sensory system	3	3		3		
CO3	Students will gain information about recent trends in application of tissue engineering	3	3		3		
Overall CO		3	3		3		

NT4015 **ENTREPRENEURSHIP** **L T P C**
3 0 0 3

OBJECTIVES:

- Study of this subject provides an understanding of the scope of an entrepreneur
- Study of this subject provides business ideas and Motivation to the students for start Business

UNIT I ENTREPRENEURSHIP **9**

Entrepreneur – Characteristics – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Role of Entrepreneurship in Economic Development – Factors Affecting Entrepreneurial Growth – Economic, Non Economic, Government Actions.

UNIT II MOTIVATION **9**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, self Rating, Business Game, Thematic Apperception Test – Stress management,Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS **9**

Small Enterprises – Definition, Characteristics, Project Identification and selection – Project Formulation: Significance, content, formulation of project report – Project Appraisal: Concept and method – Ownership Structures: Selection and Pattern.

UNIT IV FINANCING AND ACCOUNTING **9**

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT/CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS **9**

Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in Small Scale Enterprise – Institutional Support to Entrepreneurs: Need and Support - Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1:Students get knowledge business
CO2: Students Know details about Entrepreneur
CO3: Students get Motivation

REFERENCES:

1. S.S.Khanka, “Entrepreneurial Development” S.Chand& Co. Ltd. Ram Nagar New Delhi, 1999.
2. Kurahko & Hodgetts,” Entrepreneurship – Theory, process and practices”, Thomson learning 6th edition.
3. Charantimath, P. M., Entrepreneurship Development and Small Business Enterprises, Pearson, 2006.
4. Hisrich R D and Peters M P, “Entrepreneurship” 5th Edition Tata McGraw-Hill, 2002.
5. Mathew J Manimala,” Entrepreneurship theory at cross roads: paradigms and praxis” Dream tech, 2nd edition 2006.
6. Rabindra N. Kanungo, “Entrepreneurship and innovation”, Sage Publications, New Delhi, 1998.
7. Singh, A. K., Entrepreneurship Development and Management, University Science Press, 2009.

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to
CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX4092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 Ability to summarize basics of disaster
CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5 Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX4093 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

COURSE OBJECTIVES:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950 (Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094	நற்றமிழ் இலக்கியம்	L T P C 2 0 0 0

UNIT I **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)

- போரை நிறுத்திய ஔவையார்

UNIT II **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை

(தூய்மையை வலியுறுத்தும் நூல்)

UNIT III **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்

ஆகியவை பற்றிய செய்திகள்

UNIT V **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,

4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL : 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

OCE431 INTEGRATED WATER RESOURCES MANAGEMENT L T P C
3 0 0 3

OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM 9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS 9

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS 9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT 9

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM 9

Water for food production: 'blue' versus 'green' water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

CO1 Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2 Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3 Apply law and governance in the context of IWRM.
CO4 Discuss the linkages between water-health; develop a HIA framework.
CO5 Analyse how the virtual water concept pave way to alternate policy options.

REFERENCES:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.
3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.
4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.

5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

OCE432 WATER, SANITATION AND HEALTH L T P C
3 0 0 3

OBJECTIVES:

• Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH 9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT 9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality-Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT 9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:-Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE 9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES 9

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 Capture to fundamental concepts and terms which are to be applied and understood all through the study.

CO2 Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.

CO3 Critically analyse and articulate the underlying common challenges in water, sanitation and health.

CO4 Acquire knowledge on the attributes of governance and its say on water sanitation and health.

CO5 Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

1. Bonitha R., Beaglehole R.,Kjellstorm, 2006, "Basic Epidemiology", 2nd Edition, World Health Organization.

2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning:

An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda
3. National Research Council. *Global Issues in Water, Sanitation, and Health: Workshop Summary***.** Washington, DC: The National Academies Press, 2009.
4. Sen, Amartya 1997. On Economic Inequality. Enlarged edition, with annex by JamesFoster and Amartya Sen, Oxford: Claredon Press, 1997.
5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com
6. Third World Network.org (www.twn.org).

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development-millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation – climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change – Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.

CO2 Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals

CO3 Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption

CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.

CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017
3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - *George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla,* IIED and UNFPA, Earthscan, UK, 2008
5. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006
6. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION 9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION 10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert

systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological —- cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- On completion of the course, the student is expected to be able to

CO1 Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles

CO2 Understand various impact identification methodologies, prediction techniques and model of impacts on various environments

CO3 Understand relationship between social impacts and change in community due to development activities and rehabilitation methods

CO4 Document the EIA findings and prepare environmental management and monitoring plan

CO5 Identify, predict and assess impacts of similar projects based on case studies

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

OIC431 BLOCKCHAIN TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

OIC432 DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS 6

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS 9

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK 10

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 10

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C
3 0 0 3

OBJECTIVES

- To appreciate the basic concepts of vibration in damped and undamped systems
- To appreciate the basic concepts of noise, its effect on hearing and related terminology
- To use the instruments for measuring and analyzing the vibration levels in a body
- To use the instruments for measuring and analyzing the noise levels in a system
- To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

Introduction – Sources and causes of Vibration-Mathematical Models - Displacement, velocity and Acceleration - Classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration - Single Degree Freedom Systems - Vibration isolation - Determination of natural frequencies

UNIT- II BASICS OF NOISE 9

Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra - Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

Experimental Methods in Vibration Analysis.- Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings - Vibration Exciters - Mechanical, Hydraulic, Electromagnetic and Electrodynamics – Frequency Measuring Instruments -. System Identification from Frequency Response -Testing for resonance and mode shapes

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9

Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

Specification of Vibration Limits – Vibration severity standards - Vibration as condition Monitoring Tool – Case Studies - Vibration Isolation methods - Dynamic Vibration Absorber – Need for Balancing - Static and Dynamic Balancing machines – Field balancing - Major sources of noise - Noise survey techniques – Measurement technique for vehicular noise - Road vehicles Noise standard – Noise due to construction equipment and domestic appliances – Industrial noise sources and its strategies – Noise control at the source – Noise control along the path – Acoustic Barriers – Noise control at the receiver -- Sound transmission through barriers – Noise reduction Vs Transmission loss - Enclosures

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

1. Singiresu S. Rao, “Mechanical Vibrations”, Pearson Education Incorporated, 2017.

2. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000.
4. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
5. G.K. Grover, “Mechanical Vibrations”, Nem Chand and Bros.,Roorkee, 2014.
6. A.G. Ambekar, “Mechanical Vibrations and Noise Engineering”, PHI Learning Pvt. Ltd., 2014.
7. David A. Bies and Colin H. Hansen, “Engineering Noise Control – Theory and Practice”, Spon Press, London and New York, 2009.

OME432 ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS **L T P C 3 0 0 3**

COURSE OBJECTIVES:

1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I ENERGY SCENARIO **9**

Primary energy resources - Sectorial energy consumption (domestic, industrial and other sectors), Energy pricing, Energy conservation and its importance, Energy Conservation Act-2001 and its features – Energy star rating.

UNIT II HEATING, VENTILLATION & AIR CONDITIONING **9**

Basics of Refrigeration and Air Conditioning – COP / EER / SEC Evaluation – SPV system design & optimization for Solar Refrigeration.

UNIT III LIGHTING, COMPUTER, TV **9**

Specification of Luminaries – Types – Efficacy – Selection & Application – Time Sensors – Occupancy Sensors – Energy conservation measures in computer – Television – Electronic devices.

UNIT IV ENERGY EFFICIENT BUILDINGS **9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration.

UNIT V ENERGY STORAGE TECHNOLOGIES **9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- Understand technical aspects of energy conservation scenario.
- Energy audit in any type for domestic buildings and suggest the conservation measures.
- Perform building load estimates and design the energy efficient landscape system.
- Gain knowledge to utilize an appliance/device sustainably.

- Understand the status and current technological advancement in energy storage field.

REFERENCES:

1. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
2. ASHRAE Handbook 2020 – HVAC Systems & Equipment
3. Paolo Bertoldi, Andrea Ricci, Anibal de Almeida, Energy Efficiency in Household Appliances and Lighting, Conference proceedings, Springer, 2001
4. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors
6. (Could be downloaded from www.energymanagertraining.com)
7. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
8. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
9. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

OME433 ADDITIVE MANUFACTURING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need - Development - Rapid Prototyping Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation Customized Design and Fabrication - Case Studies.

UNIT III VAT POLYMERIZATION 9

Stereolithography Apparatus (SLA)- Materials -Process -Advantages Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

UNIT IV MATERIAL EXTRUSION AND SHEET LAMINATION 9

Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials- Application and Limitation - Bio-Additive Manufacturing Computer Aided Tissue Engineering (CATE) – Case studies

POWDER BASED PROCESS

Selective Laser Sintering (SLS): Process –Mechanism– Typical Materials and Application- Multi Jet Fusion - Basic Principle-– Materials- Application and Limitation - Three Dimensional Printing - Materials -Process - Benefits and Limitations. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials -Benefits -Applications.

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES **9**

Education and training - Automobile- pattern and mould - tooling - Building Printing-Bio Printing - medical implants -development of surgical tools Food Printing -Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

TOTAL: 45 PERIODS

REFERENCES:

1. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 2nd edition, Springer., United States, 2015, ISBN13: 978-1493921126.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590
4. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
5. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

OME434 ELECTRIC VEHICLE TECHNOLOGY **L T P C**
3 0 0 3

UNIT I NEED FOR ELECTRIC VEHICLES **9**

History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE **9**

Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE **9**

Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell

UNIT IV ELECTRIC DRIVES AND CONTROL **9**

Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control , AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES **9**

Materials and types of production, Chassis skate board design, motor sizing, power pack sizing, component matching, Ideal gear box – Gear ratio, torque–speed characteristics, Dynamic equation of vehicle motion, Maximum tractive effort – Power train tractive effort Acceleration performance, rated vehicle velocity – maximum gradability, Brake performance,

Electronic control system, safety and challenges in electric vehicles. Case study of Nissan leaf, Toyota Prius, tesla model 3, and Renault Zoe cars.

TOTAL: 45 PERIODS

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained - Wiley, 2003.
4. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005

OME435	NEW PRODUCT DEVELOPMENT	L	T	P	C
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COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Applying the principles of generic development process; and understanding the organization structure for new product design and development.
- Identfying opportunity and planning for new product design and development.
- Conducting customer need analysis; and setting product specification for new product design and development.
- Generating, selecting, and testing the concepts for new product design and development.
- Appling the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCTDESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development – Duration and Cost of Product Development – The Challenges of Product Development – The Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition – Types of Opportunities – Tournament Structure of Opportunity Identification – Effective Opportunity Tournaments – Opportunity Identification Process – Product Planning: Four types of Product Development Projects – The Process of Product Planning.

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs – The Process of Identifying Customer Needs. Product Specifications: Definition – Time of Specifications Establishment – Establishing Target Specifications – Setting the Final Specifications

UNIT IV CONCEPT GENERATION, SELECTION & TESTING 9

Concept Generation: Activity of Concept Generation – Structured Approach – Five step method of Concept Generation. Concept Selection: Methodology – Concept Screening and Concepts Scoring. Concept testing: Seven Step activities of concept testing.

UNITV INDUSTRIAL DESIGN & PROTOTYPING 9

Industrial Design: Need and Impact–Industrial Design Process. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development "McGraw-Hill Education; 7 edition, 2020.

REFERENCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Rosenthal S.,"Effective Product Design and Development", Business One Orwin,Homewood, 1992,ISBN1-55623-603-4.

OBA431 SUSTAINABLE MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY 9

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY 9

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES 9

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainabilityperformances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize students with the theory and practice of small business management.
- To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY 9

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.

Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS 9

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small

firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT 9

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). "The key factors in the profile of small firm owner-managers that influence business performance. The South Coast Small Firms Survey, 1997-2000." Industrial and Commercial Training 32(3):94-98.
2. Parker,R.(2000). "Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia." Australian Journal of Political Science 35(2):239-253.
3. Journal articles on SME's.

OBA433 INTELLECTUAL PROPERTY RIGHTS L T P C

3 0 0 3

COURSE OBJECTIVE

- To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION 9

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS 9

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES 9

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS 9

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

OBA434 ETHICAL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVE

- To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY 9

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations- Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS 9

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT 9

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT 9

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology-ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS 9

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.
2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.
3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

ET4251 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

1. To study about **Internet of Things** technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT 9

PROTOCOLS:

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.

Embedded processors for IOT :Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.

CO2: Compare and contrast different platforms and infrastructures available for IoT

CO3: Explain different protocols and communication technologies used in IoT

CO4: Analyze the big data analytic and programming of IoT

CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “ Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

ET4072 MACHINE LEARNING AND DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

The course is aimed at

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL : 45 PERIODS

COURSE OUTCOMES (CO):

At the end of the course the student will be able to

CO1 : Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.

3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman.
Second Edition. 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO_2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS 9
Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell-characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9
Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.

CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

PS4093 SMART GRID L T P C
3 0 0 3

COURSE OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the function of smart grid.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications
- To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Unit V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to

CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5**:** Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3. Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CP4391 SECURITY PRACTICES L T P C

3 0 0 3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture -A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN : 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

MP4251 CLOUD COMPUTING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 6

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization – Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE 12

Cloud Computing: Definition, Characteristics -73Cloud deployment models: public, private,

hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops

UNIT V PROGRAMMING MODEL 9

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner"s Guide‖, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

IF4072 DESIGN THINKING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX

- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE 8

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster Value Proposition. What Is a Value Proposition?.

UNIT II CONTEXTUAL INQUIRY 10

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING 9

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS 8

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE 10

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:

1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018
2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012
3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018
4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA L T P C
3 0 0 3

COURSE OBJECTIVES:

- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION 9

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA 9

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS 9

Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis.

Suggested Activities:

1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:

1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS 9

ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval.

Suggested Activities:

1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:

1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.
2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.
3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)

4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of big data analytics
- To understand the search methods and visualization
- To learn mining data streams
- To learn frameworks
- To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies –Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing -Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames -Classes, Input/output, String manipulations

COURSE OUTCOMES:

CO1:understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4:gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL:45 PERIODS

REFERENCE:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

NC4201 INTERNET OF THINGS AND CLOUD L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT 9

Introduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors.

UNIT II PROTOCOLS FOR IoT 9

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION 9

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD 9

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core -Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1: Understand the various concept of the IoT and their technologies..
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

MX4073 MEDICAL ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS 9

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS 9

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS 9

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS 9

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art and Recent Advances, Springer, 2016
6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd, England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

VE4202 EMBEDDED AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To learn about the process involved in the design and development of real-time embedded system
- To develop the embedded C programming skills on 8-bit microcontroller
- To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
- To learn about the tools, firmware related to microcontroller programming
- To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING 9

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER 9

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS 9

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED

Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM 9

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION 9

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES:

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.
2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.
3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012
4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.
5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.
6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.